Final Report

Vegetational Status of the Freshwater Tidal Marshes of the Upper Cooper River

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Introduction

South Carolina coastal river systems have a freshwater tidal region that was modified for rice culture during the 18th and 19th centuries. River swamp and marsh were converted to level bottomed fields of nearly uniform depth. Dikes, ditches and trunks controlled water levels. Accounts of the origins of rice culture and the day to day practices of growers are found in Heyward (1937), Hawley (1949), Doar (1970) and Porcher (1985). The industry had ended by the 1920s through loss of the labor force, mechanized production in competing areas and storm damage. Many fields were abandoned. Breaches in dikes allowed the return of daily tidal flow and set in motion an aquatic succession process. Today these fields are found in a variety of successional states. The present condition of individual fields is determined by cultivation history, management practices, time of abandonment, water depth, duration of cover, salinity, and possibly other factors.

Interest in plant species composition, primary productivity and successional processes occurring in these systems can be traced to Wells (1928) and to more recent studies by Baden (1971), Stalter (1972), Baden et al. (1975), Gresham and Hook (1982), Williams et al. (1984), Pickett, McKellar and Kelley (1986), Kelley, Porcher and Michel (1990) and Stalter and Baden (1994). Reports that record biological, chemical and physical data specifically for the Cooper River include Adams (1972), Christie (1978), Curtis and Christie (1983), Homer and Williams (1985), Nelson (1974), U.S. Army Corps of Engineers (1975), Lagman et al. (1980), Williams et al. (1984) and Van Dolah et al. (1990).

As the U.S. Army Corps of Engineer developed plans to reroute some of the Cooper Rivers' freshwater flow to the Santee River (Cooper River Rediversion Project, COE, 1975), models predicted lowered water levels in the Cooper River. This suggested to us the likelihood of accelerated successional change in marsh vegetation. Changes measured in decades in other river systems might be measured in years or even months in the Cooper. The project created an opportunity to document and model the rate and patterns of succession. Observable differences in plant composition, animal presence and human use among the various stages also suggested that successional change might result in the loss (gain) of some functions and uses over time. Beginning in 1977, Kelley & Porcher and later McKellar and others collected prediversion quantitative and observational data in four tidal remnant rice fields in the Cooper system. Status reports were published in 1986 (Pickett, McKellar and Kelley) and 1990 (Kelley, Porcher and Michel). In the present project, our objectives are

1. To produce a species list of all vascular plants collected and observed in our study sites over the 1982-1994 interval.

2. To produce vegetation maps showing the changes in the distribution of plant communities in the study sites over the 1982-94 interval.

3. To compile a ground level and low level aerial photographic record of remnant rice fields on the Cooper system.

4. To propose a successional pattern for Cooper system tidal freshwater marsh.

5. To discuss the implications of succession on habitat diversity, ecological function and recreational opportunity in the Cooper system.

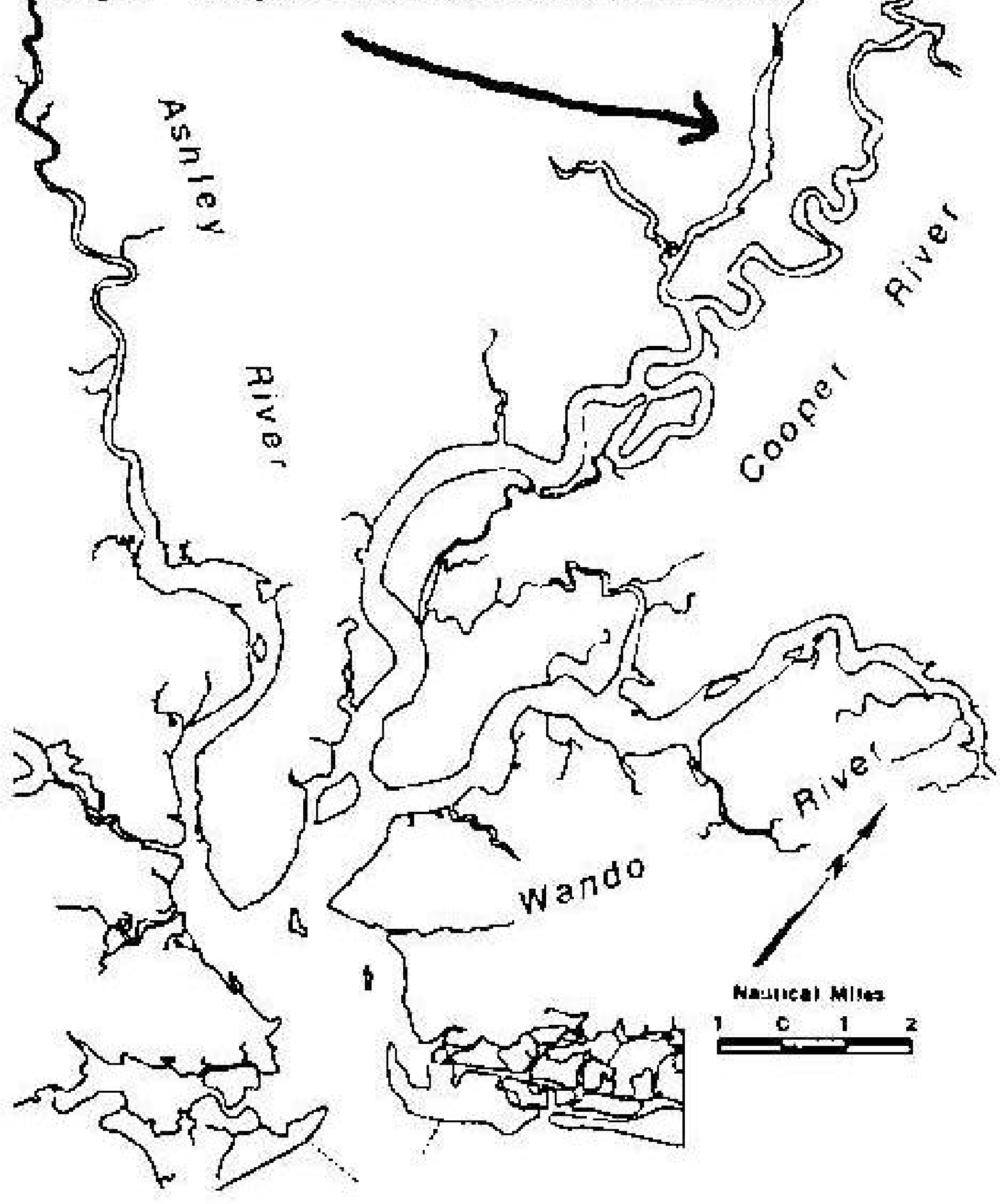
6. To identify research problems for future study.

Methods

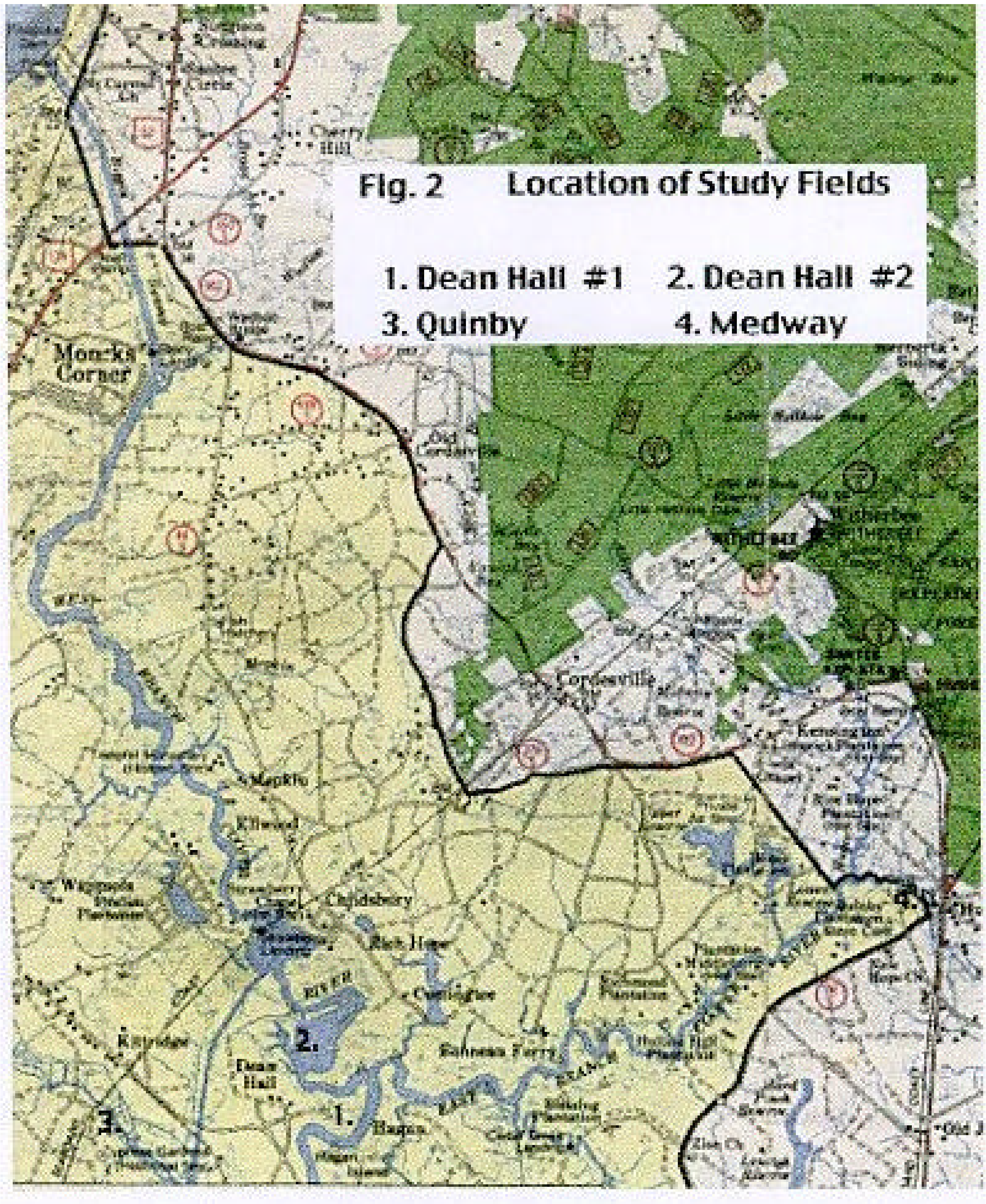
Study Site/Study Period

In 1985 water levels in the upper Cooper River near Charleston, S.C. (figs. 1 & 2) dropped as much as 15cm (Kelley et al., 1990), as a result of the Cooper River Rediversion Project. In anticipation of vegetational changes in intertidal marsh, Kelley and Porcher (unpublished) and Pickett, McKellar and Kelley (1983) began prerediversion surveys of remnant impoundments along the East and West branches of the Cooper and of the Back River tributary. In 1977-79 Kelley and Porcher identified and visually characterized 80 old rice fields with breached dikes that were open to tidal fluctuation and 21 impoundments with dikes and water control structures still functioning. Pickett, McKellar and Kelley (1986) selected one tidal field, Dean Hall (fig. 2), located at the T (junction of East and West branches) for a detailed vegetation survey and primary production study. Kelley and Porcher (unpublished) collected quantitative species composition and biomass data during the same time period at 3 other locations: Dean Hall #2, Medway and Quinby (Fig. 2). The 4 fields, Dean Hall, Dean Hall#2, Medway and Quinby, were chosen because they appeared to represent a successional series ranging from open water/submergent macrophyte dominated at Dean Hall#2 to grass/sedge dominated with some tree cover at Medway. Kelley, Porcher and Michel (1990) repeated the Dean Hall study in 1989 to evaluate vegetational changes since the 1985 rediversion. Kelley and Porcher also continued sampling at Dean Hall#2, Medway and Quinby in 1988 and 1989. In the present 1994-1995 study Kelley and Porcher have revisited, visually classified and photographed all of the upper Cooper fields surveyed in 1977. We have extended the quantitative species composition and biomass work done earlier at Dean Hall, Dean Hall#2, Medway and Quinby. In this project, we have added low level aerial photography and computerized analysis of digitalized color infrared aerial photography to our study.

Fig. 1 - Cooper River Freshwater Tidal Zone



Quantitative field sampling methods: In 1982 and 1989, 25 randomly distributed $1/4m^2$ quadrats were collected each month from the Dean Hall field. 10 to 20 random $1/4m^2$ quadrats were harvested seasonally at Dean Hall #2, Medway and Quinby during the same time period. In 1994-95, 20 random quadrats were collected from each of the 4 fields during the time of peak community biomass and species abundance (June- September). All quadrats were collected by cutting plant stems at ground level. Samples were sorted to species, dried and weighed. Records of salinity, pH and soil moisture content were recorded at many of the sample sites.

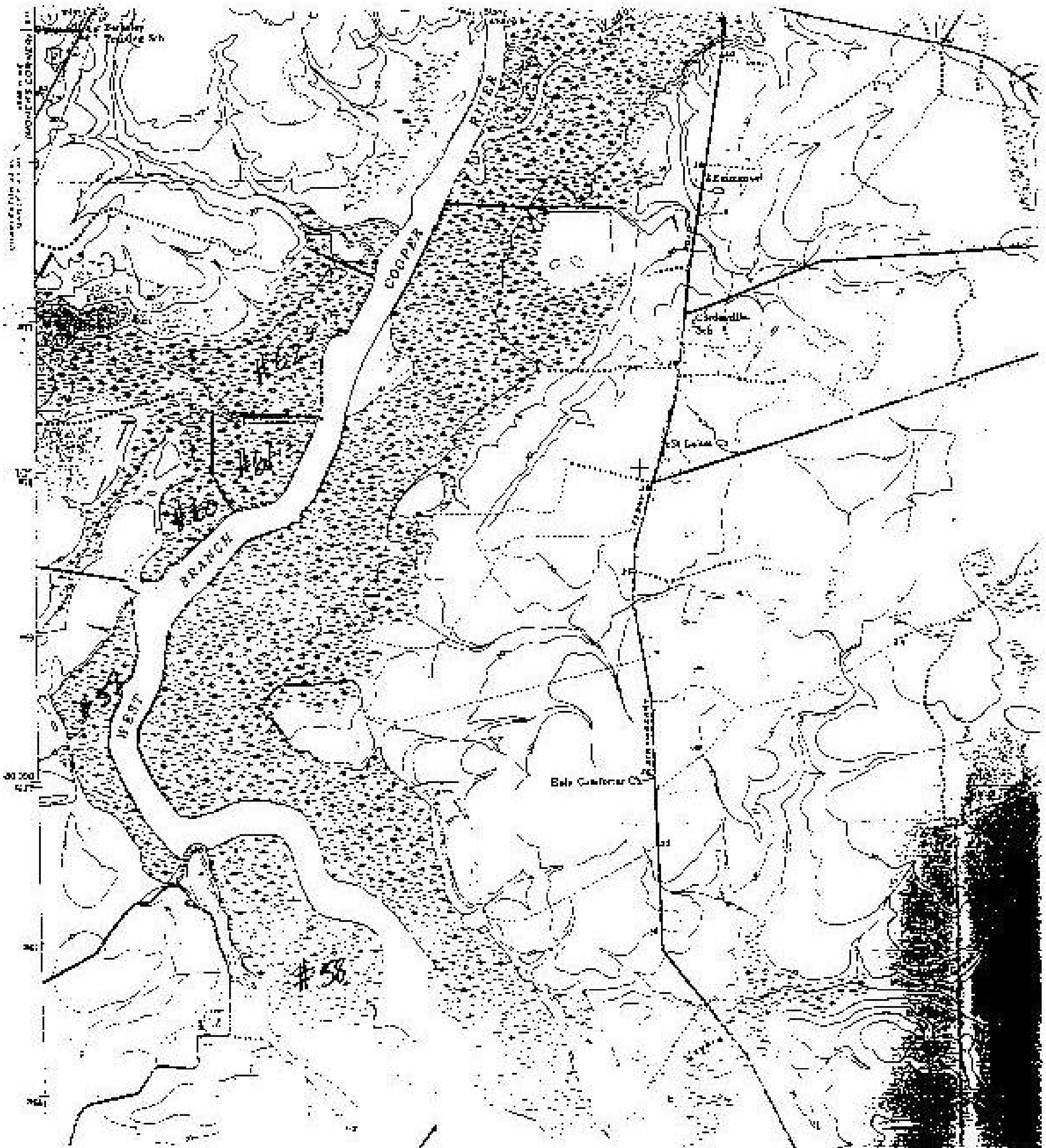


Observational/photographic methods. In 1994 Kelley and Porcher returned to each of the fields visited in 1977-79. A field numbering/identification system is shown in Figure 3. We photographed each field from near ground level and recorded a visual classification of the field to compare with visual classifications made similarly in the late 1970s. In the Fall of 1994 and again in 1995 we photographed the fields from the air (800 - 1200 ft above ground). Flight paths are also shown in Figure 3. Both sets of photography are appended to this report.

Fig. 3 Field Numbering System

ITED STATES
NT OF THE INTERIOR
OGICAL SURVEY
UNITED STATES
DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
Irwin Chapel
Upper Reserve
Lower Reserve
Bossis Plantation
Quinby Sch
Quinby Plantation
Huger
New Hope
COOPER RIVER
Pompion Hill Chapel
Middleburg Plantation
Richmond Plantation
EAST BRANCH
Hollon Hill Plantation
New Hope Sch
F R A N C I S M
#9
#10
#29
#30
#31
#32
#33
#34
#7
#6
#8
#23
#24
#26
#25
#27
#28

Hopkin
#62
#51
BRANCH
COOPER
#50
#49
Childsbury
Strawberry Chapel
#48
RIVER
Rice Hope
#47
#45
#46
#44
#43
#42
#2
Dean Hall
#1
Kittredge
Wappoola
Elwood



#57

BRANCH
COOPER
RIVER
Tabo Ch
Strawberry Chapel
Strawberry Landing
Promised Land Ch
Kittredge
Dean Hall
Cypress

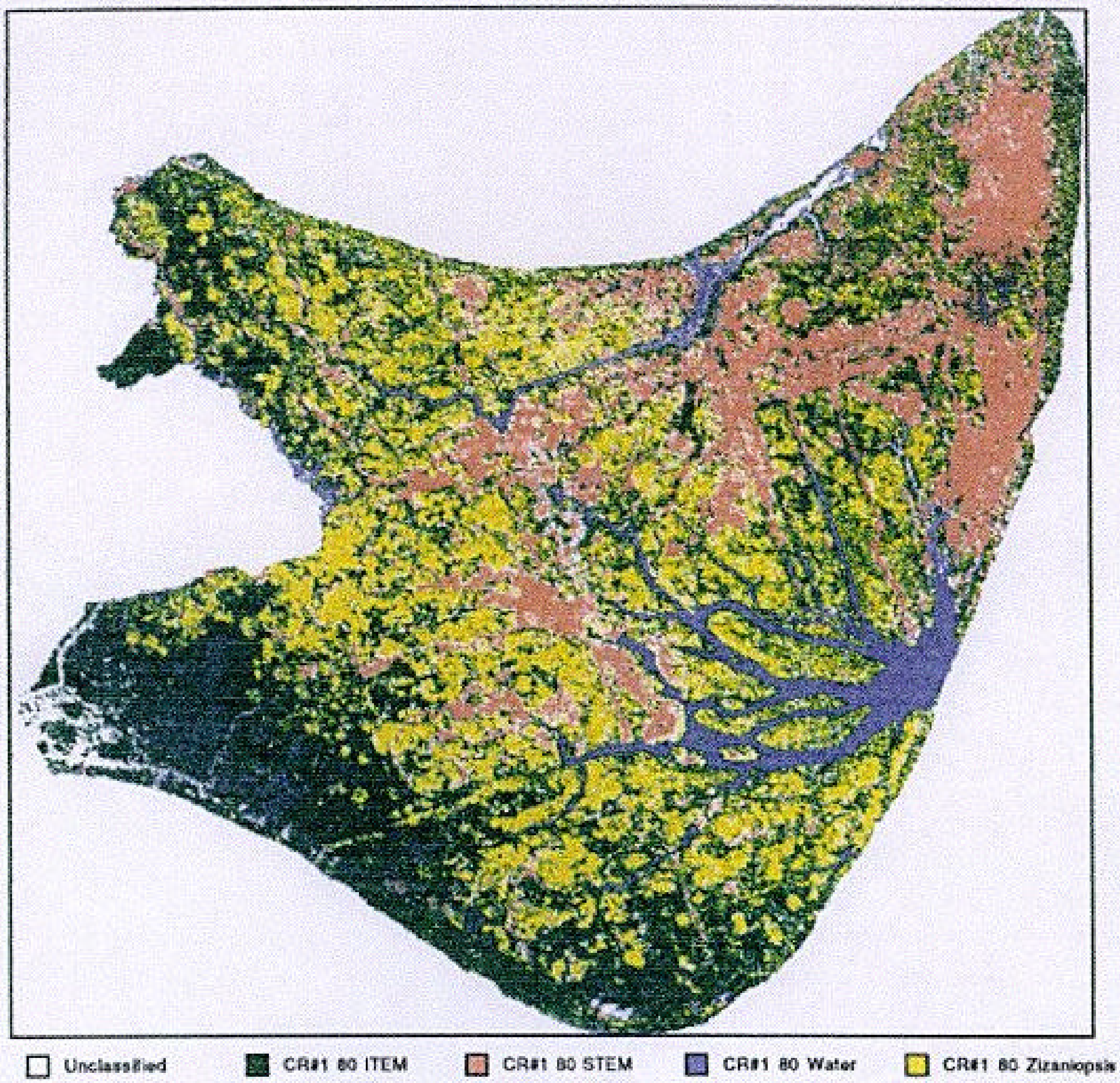
Analysis/classification of color IR aerial photography. Images used include: 1. Color infrared (IR) transparencies (NAPP photography -1/40,000 and other larger scale IR photography) obtained from the S. C. Office of Coastal Resources Management, 2. A digitalized, color balanced, rectified and registered set of 1994 images obtained from the S.C Land Resources Commission and 3. Our own low level Ektachrome slide photography. OCRM photography was scanned on a Topaz commercial scanner at 300DPI and stored on SyQuest 270MB cartridges. Ground coordinates used in rectifying and registering the images were obtained using a S.C. Land Resources Commission Trimble GPS system. Unique patterns of ditches and other landmarks made it possible to match randomly chosen ground sample sites to coordinates on a gridded map and vegetation patches in aerial photos. Low level slide photography and quadrat data were used in confirming community classifications of aerial IR analyses. Image analysis was performed on a MacIntosh 8100 system using Dimple image analysis software.

Results

Dean Hall

Using winter 1981 color IR aerial photography and growing season 1982 ground sampling data, we produced the Dean Hall classification shown in Fig. 4. In 1981-82 the flat intertidal areas between ditches were dominated by either dense stands of Zizaniopsis (called white marsh locally) and Pontederia (pickerel weed), 13.7% cover, or by a more complex mixture of species (called ITEM = intertidal emergent mix) including Pontederia, Lycopus, Alternanthera, Zizaniopsis, Peltandra and others, especially the vines Apios,Cuscuta and Mikania, 20.5% cover. Figures 5 &6 present 1982 species frequency and July 1982 biomass data summaries. 29 species were collected in quadrat samples with 90% of the biomass being concentrated in 10 species. Soils were saturated at all tides and salinity measured with a refractometer was never above 0. Soil pH was nearly uniform over the entire field at about 7.6 . Repeated sitings were made of wood ducks, mallards, ibis, coots, gallinules, king rails, great blue herons and red winged blackbirds. Alligators, turtles, bream, bass and mudfish were common in or on the edges

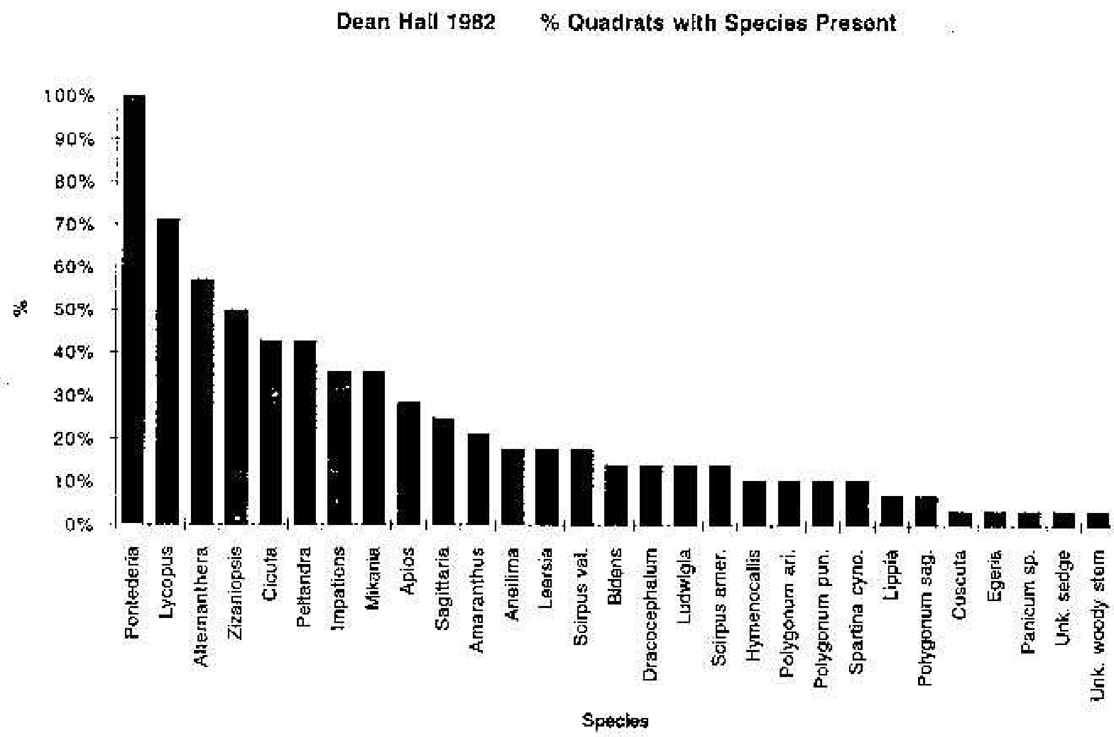
Fig. 4 Dean Hall # 1 Winter 1981



Community	Area (m2)	% Cover
ITEM Mix	256892	20.5
Ludwigia	115639	9.2
Zizaniopsis	171742	13.7

of ditches and cotton- mouth moccasins, fiddler crabs (Uca minax), gammarid amphipods, rabbits and deer in the intertidal flats. Noticeably absent: mosquitos, biting midges, and flies. Peltandra, Zizania, Polygon sp. and other plant species present are known to be attractive foods to various birds (McAtee, 1911, Landers et al. 1976). Ditches were mostly open to boat passage but some shallow areas were being closed by

Fig. 5



the submergent/low emergent Ludwigia uruguayensis. Bass and bream fishermen in boats were regularly seen in the dike breaches and inside the field in the deeper open water ditches. Areas deeper into the field and closed to boat passage were often the places where most of the vertebrate wildlife was found.

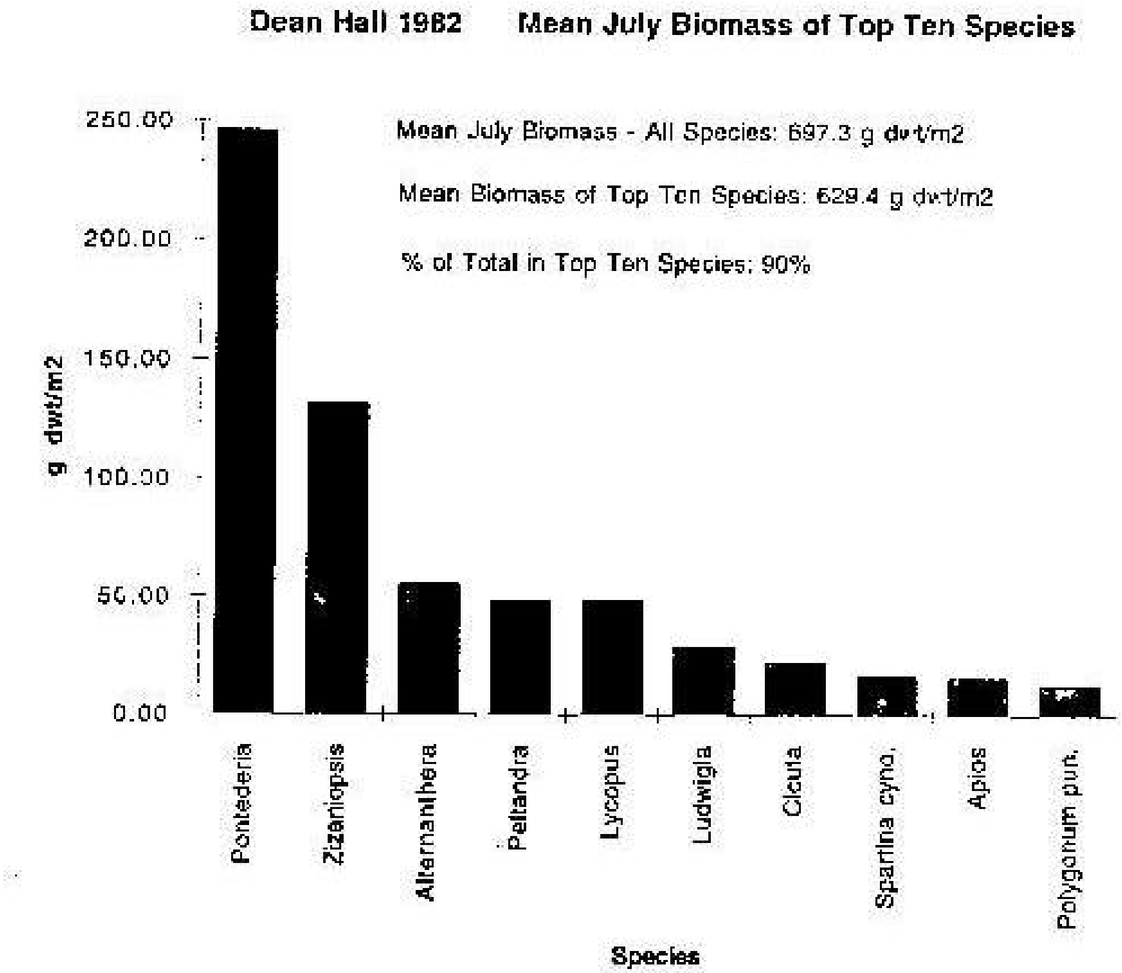
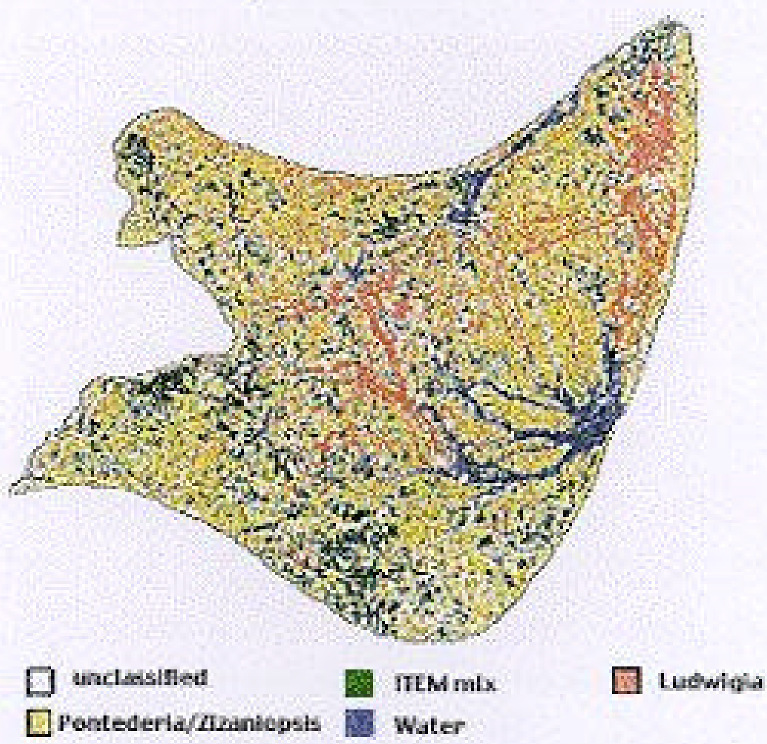


Figure 6

Figure 7 is a classification of a spring (April) 1982 aerial photo taken approximately 14 months after the 1981 winter photo used to produce Fig. 4. It shows the striking difference in community composition and cover associated with seasonal succession. By February in most years, winter die back has reduced the standing green biomass of ITEM areas in the field to flat rosettes of plants like Dracocephalum and Lobelia with Alternanthera often making the largest % contribution to quadrat live biomass. By March new growth of broad leaf perennials like Peltandra, Pontederia, Sagittaria and Cicuta predominates with grasses and sedges; e.g., Zizaniopsis and Scirpus pushing through to form an overstory later in the season. Vines and midstory additions; e.g., Lycopus and Bidens, complete the development of quadrat complexity by June/July. Accurate production estimates take into account the progression of biomass peaks that occur throughout the growing season (Pickett, McKellar and Kelley, 1986).

Fig. 7 Dean Hall # 1 Spring 1982



Community	Area (m2)	% Cover
ITEM Mix	67736	9.5
Ludwigia	76374	10.7
Pontederia/Zizaniopsis	273331	38

No classification figure for 1988-89 is presented for Dean Hall because adequate 1988-89 aerial photography for Dean Hall was unavailable. This is the time period however when intensive field sampling was done at Dean Hall and the following comparisons to 1982 characterizations were reported in Kelley, Porcher and Michel (1990): 1. Water levels had decreased 2. The flora was more diverse 3. The standing crop of some dominants had decreased 4. The cover (frequency) of approximately 1/3 of the species common to both years increased, with most of these being subdominant understory species and 5. Seasonal successional patterns were different. The 1982 dominants Pontederia (pickerel weed), Zizaniopsis (white marsh) and Lycopus were less frequent in 1988 (figs. 5 & 8). White marsh biomass also declined in 1988 (figs. 6 & 9).

Fig. 8

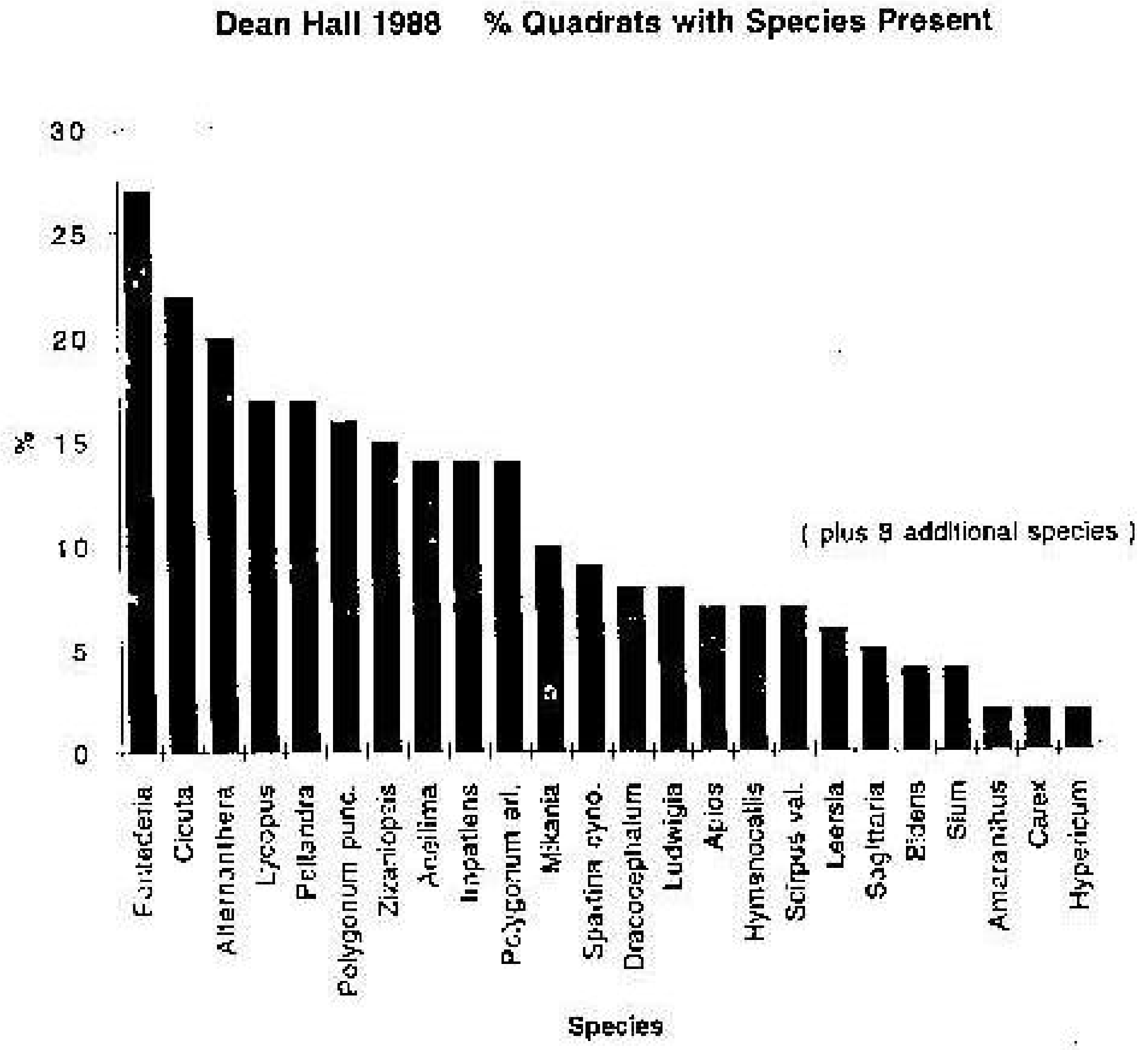


Figure 10 is a classification of Dean Hall as it appeared in 1994 photography. Zizaniopsis dominated quadrats appear to have diminished dramatically from 1982 and 1988 counts. The dominance still shown by white marsh in average biomass (fig. 11) results from the fact that several of the 1994 quadrat samples fell in dense stands of

Zizaniopsis. Standing crop in these dense stands is very high and skewed the biomass data to favor

Zizaniopsis. A similar apparent contradiction seems to exist when 1982 – 1994 Ludwigia frequency and cover are examined (figs. 4, 10 and 12) which is explained

Fig. 9

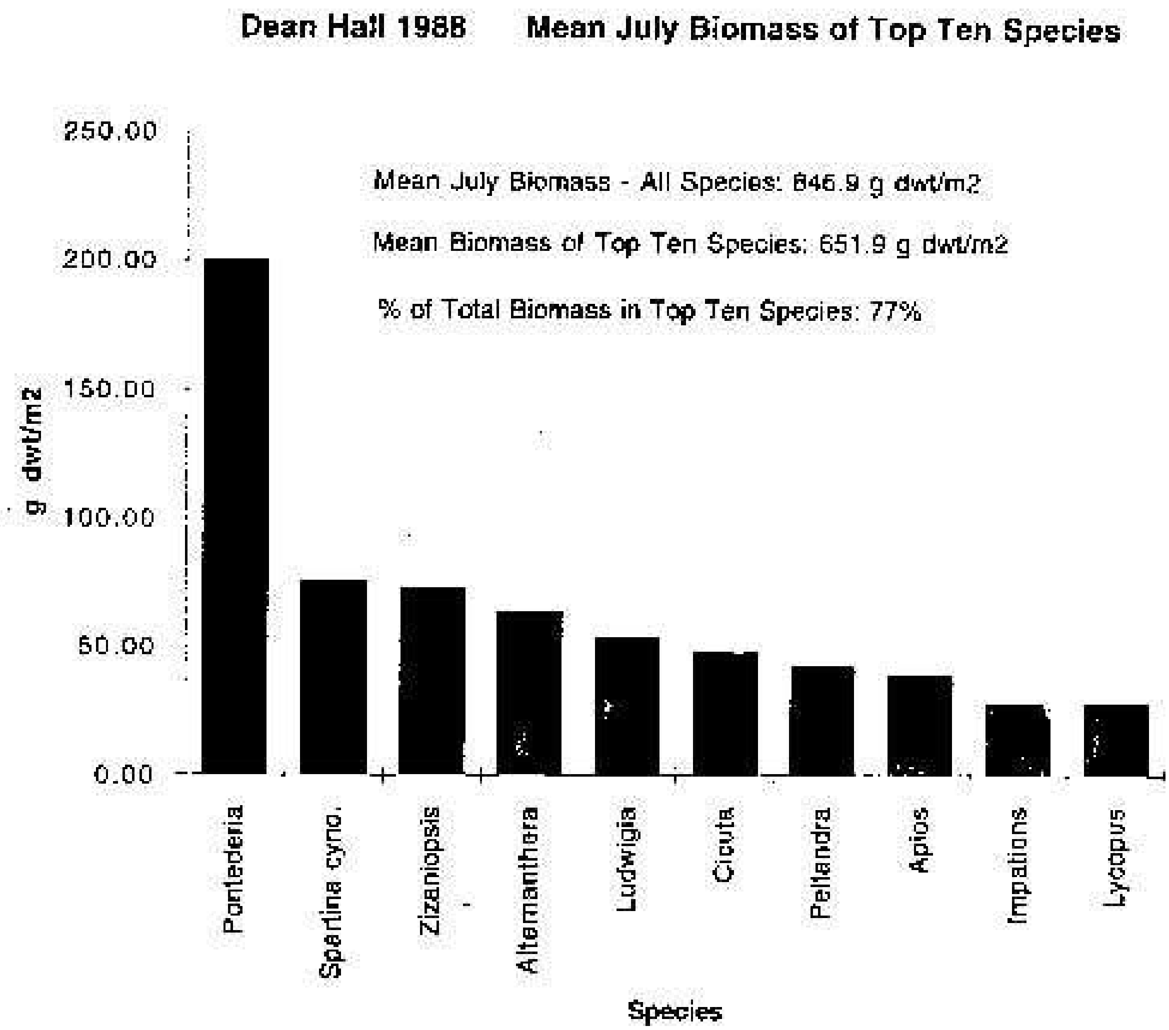
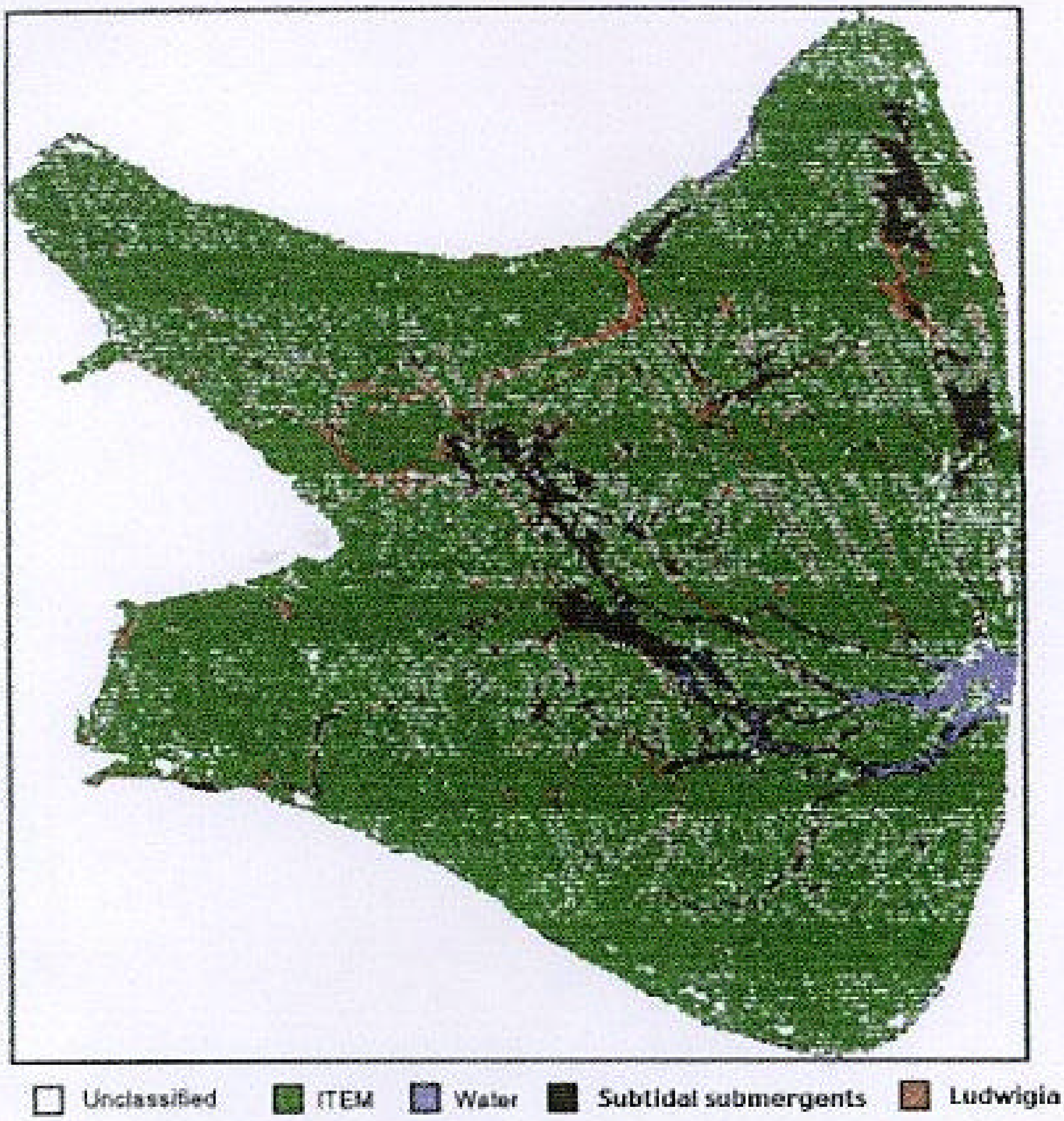


Fig. 10 Dean Hall # 1 Winter 1994

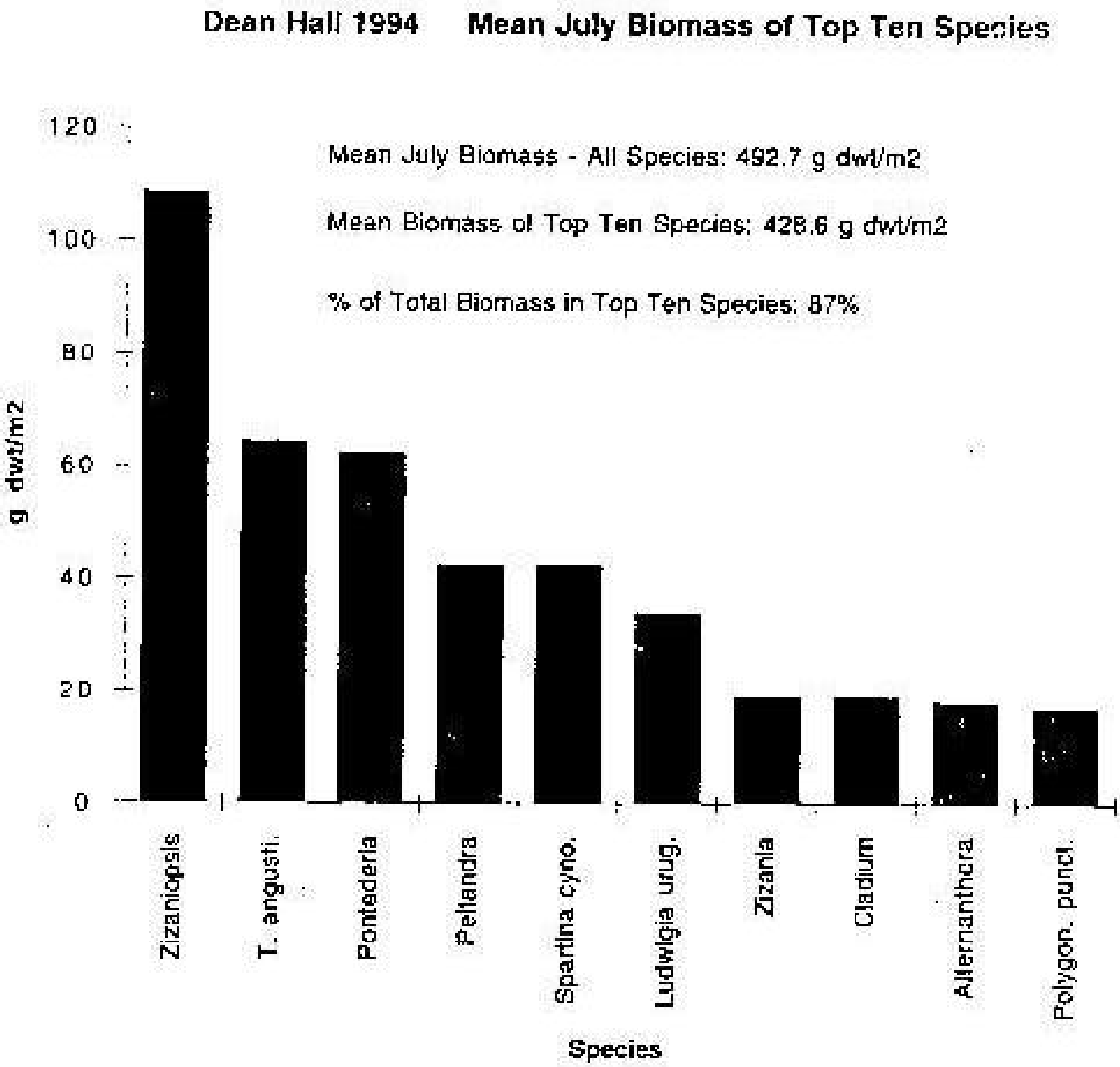


Community	Area(m2)	% Cover
ITEM mix	452392	41
Ludwigia	18006	1.6
Subt Submergent	36812	3.3

by the combination of a hard frost and a high tide aerial photograph. A hard frost kills the above water portions of the plant leaving the submerged portions untouched. Also the detection of Ludwigia in winter aerial photography is affected strongly by tide stage. As high tide water fills ditches and low spots in inter-ditch areas where Ludwigia is found, image recognition sets for water classify the areas as water rather than Ludwigia. A low Ludwigia % cover estimate is produced while on the ground sampling indicates a wider distribution of the species.

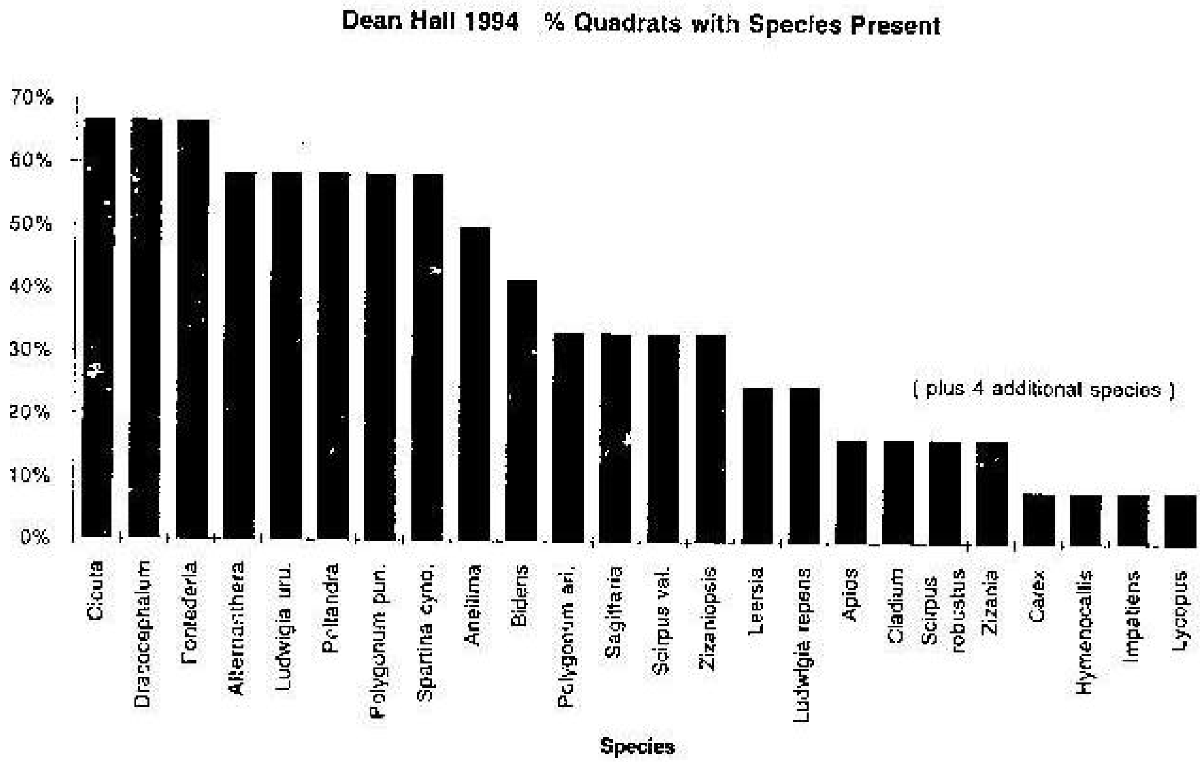
The expansion of the more complex ITEM community appears to be clear in both the 1994 classification figure and in the 1994 frequency/biomass data.

Fig. 11



Dean Hall 1994 Mean July Biomass of Top Ten Species
Mean July Biomass - All Species: 492.7 g dwt/m2
Mean Biomass of Top Ten Species: 428.6 g dwt/m2
% of Total Biomass in Top Ten Species: 87%
g dwt/m2
120
100
80
60
40
20
0
Zizaniopsis
T. angusti.
Pontederia
Peltandra
Spartina cyno.
Ludwigia urug.
Zizania
Cladium
Alternanthera
Polygon. punct.
Species

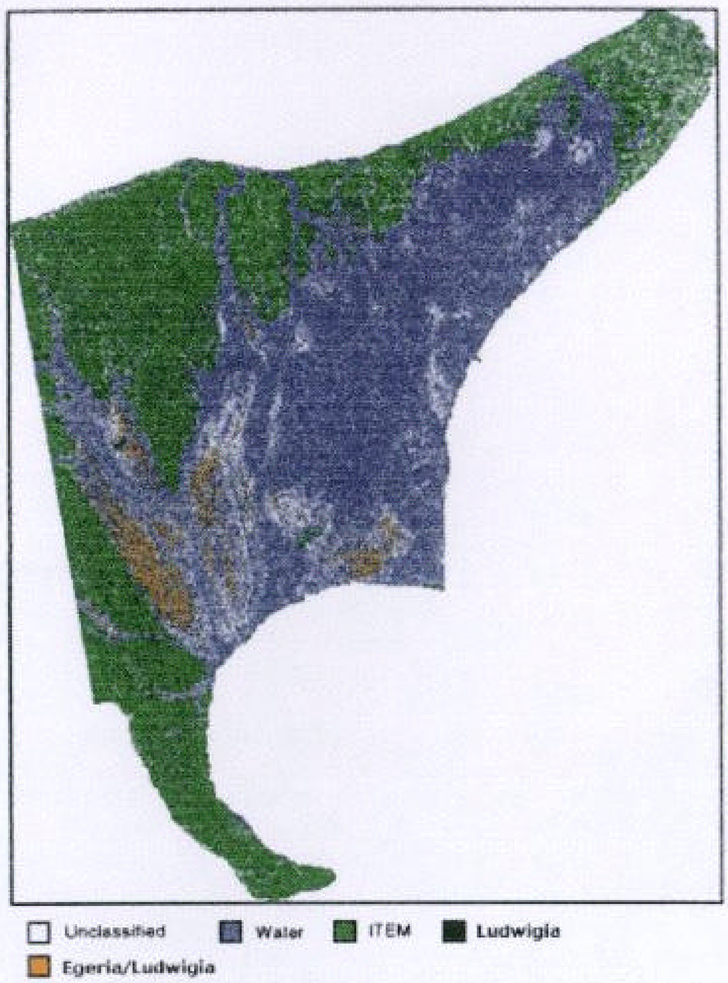
Fig. 12



Dean Hall #2

Dean Hall#2 is adjacent to Dean Hall (fig. 2), having been part of the same plantation. It was chosen because in the late 1970s it had a large percentage of its total area in open water with submergent macrophytes. In this field, ditches and low spots had no emergent cover nor did much of the inter-ditch flat area. It was considered to represent the youngest successional stage in the Cooper sere. Figures 13 and 14 show community cover in spring 1982 and winter 1994. The seasonal differences in the two photographs available make comparison of the two classifications difficult. Ludwigia was not recorded in quadrats in 1982 (fig.15) and 1988 (fig. 16) but was observed to be present in scattered patterns especially among beds of Egeria. During the 1982 - 1994 study period, it increased from a scattered presence in 1982 and 1988 to a biomass dominant in 1995 (figs. 17, 18 & 20). The presence of Ludwigia in quadrats (Fig. 19) in 1994 and as a recognizable classification set in 1994 is an indication of an important successional step in the Dean Hall #2 field. Further, the actual distribution of Ludwigia in

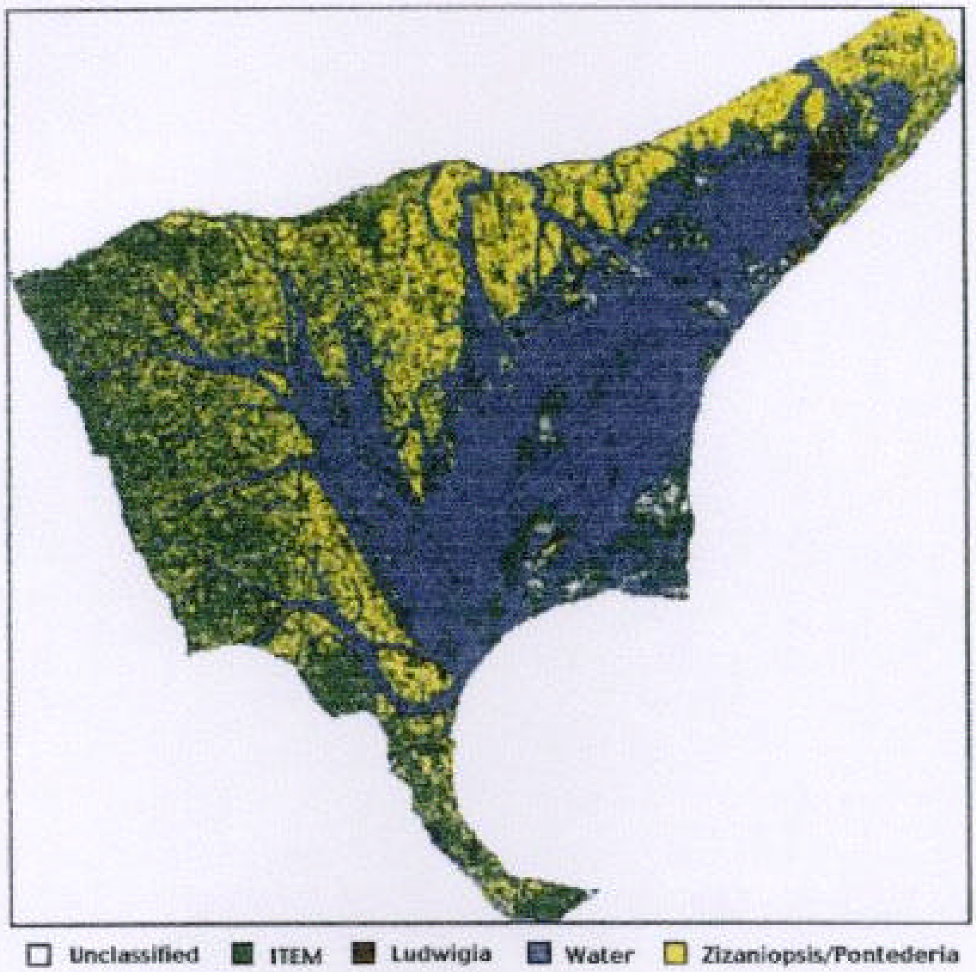
Fig. 13 Dean Hall # 2 Spring 1982



Community	Area (m2)	% Cover
Egeria/Ludwigia	270198	10.1
ITEM mix	261279	9.8
Pontederia/Zizaniopsis	164387	6.1

the open water areas of Dean Hall #2 in 1994 is far greater than the winter photography shows (see color slides taken in the fall of 1994 and 1995 before freezes which kill above

Fig. 14 Dean Hall #2 Winter 1994



Community	Area (m2)	% Cover
Ludwigia	51423	1.6
ITEM mix	473788	14.6
Zizaniopsis/Pontederia	299972	9.2

the water portions of the plant). In the Cooper system, the transition between open water with submergents to rooted emergents seems to be accomplished primarily by Ludwigia uruguayensis. Eichornia (water hyacinth) has recently, since 1988, become another factor in the closing of open water in the Cooper. Although it is not rooted, it becomes trapped in Ludwigia mats and often appears in the same position over time. The apparent differences in emergent species in inter-ditch areas seen in Figures 13 & 14 may be due

to seasonal differences in the same communities. Comparison of summer data from 1982 (fig.17) and 1995 (figs. 20) suggested little change in species composition or biomass distribution in inter-ditch emergent communities over the period. Lycopus, prominent in frequency and biomass in 1982, seems to be losing importance in 1994 (fig. 20), as it did in similar areas in Dean Hall during the same period).

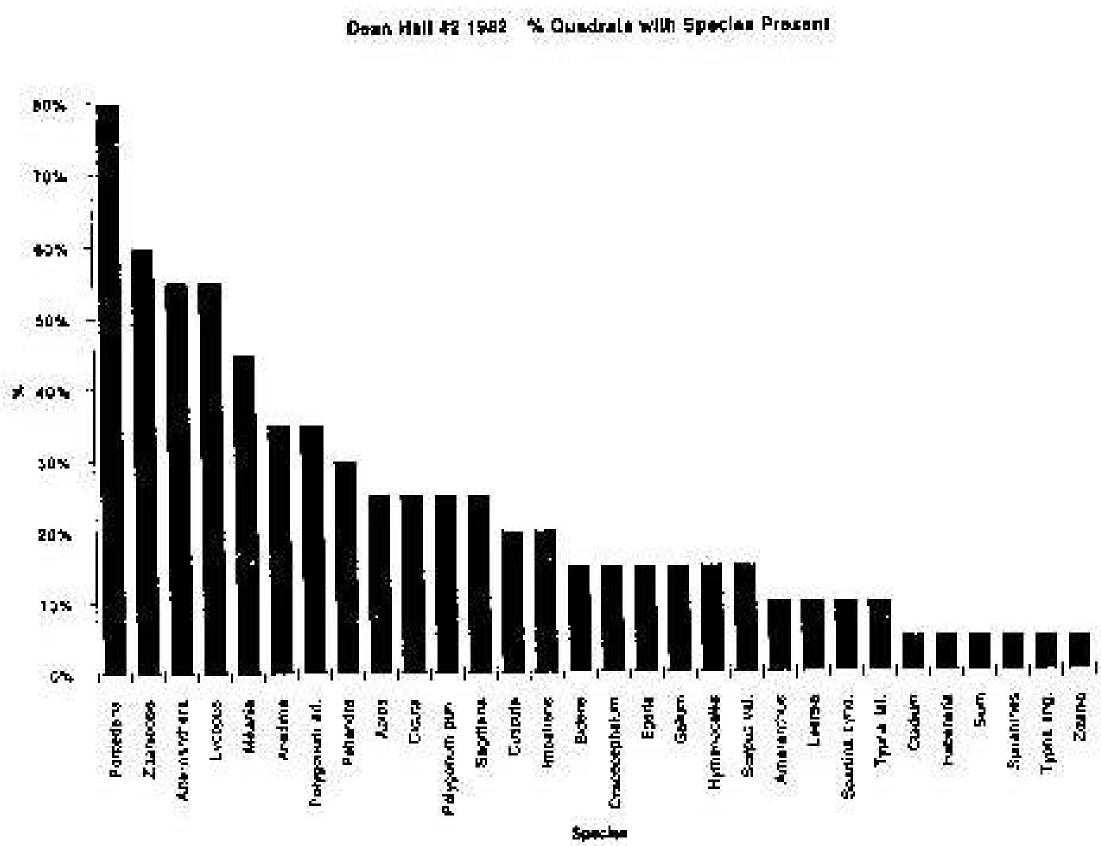


Figure 15